SYSTEM AND METHOD FOR IMAGE TRANSFER OF MEDICAL FILM

TECHNICAL FIELD

The present invention relates to a system and a method, respectively, for transfer of medical films, particularly X-ray films or parts thereof, for diagnostics to digital, electronic form and for filing of these digital, electronic images.

BACKGROUND OF THE INVENTION AND RELATED ART

From the start of X-ray diagnostics it has been common practice to compare films from different examinations of a patient as required. The main purpose is to search for and to diagnose pathalogically interesting changes, e.g. of tumours. New techniques for imaging, such as e.g. ultrasonics and nuclear magnetic resonance, have successively been introduced in parallel with the X-ray technique. To this also common photographic images are added as a supplementary aid.

A comparison between so-called old images from previous examinations and new images from a present examination is carried out either by hanging and examining existing films in front of a light surface, e.g. in a light cabinet, or by examining computerized, so-called digitized images on a computer screen. The diagnosis is rendered difficult to a varying extent if the comparison is not performed between old and new images at similar conditions and with the same tecnique, i.e. in a light cabinet or on a screen.

As regards examinations using X-rays, a transition has during the latest five years successively taken place from so-called analogous film technique to so-called digital technique with screens and this transition is

estimated to continue during about 5 to 10 years for large and medium-sized diagnostic units and up to 15 years for smaller units.

An important diagnostic operation routine, particularly for large and medium-sized diagnostic units, is the so-called round system, which in principle comprises a consultation between clinics with different specialist competence, including diagnosticians, mainly within X-ray, ultrasonic sound and magnetic resonance imaging (MRI). During the rounds the respective clinics are going through the basis for all or selected examinations together with the diagnostician reporting on the case before determining the patient diagnosis that is at hand. The number of participants of the round varies from a few to about twenty. The number of rounds tends to increase but with fewer participants, principally dependent on the possibility of a greater flexibility at the presentation on digital screens within the diagnostic unit. Examinations using computer tomography, ultrasonic sound and magnetic resonance imaging are often presented with various image divisions, the number of which may vary from two to twenty, of the same object, which correspondingly makes the readability more difficult due to the decreasing size of the images. Therefore, some light cabinets have been completed with a video system, which comprises a movable video camera in front of the light surface and a television monitor for presentation of enlarged films.

In order to meet the demand of image examination during similar conditions and preferably using the same technique old films are transferred to digital, electronic form by so-called scanning. The films are then placed into a scanner, which is a closed unit, for reading and transfer, such as a data file, to a digital archive, e.g. in a PACS (Picture Archiving and Communications

System), which is a complete digital information system comprising a digital image archive with a network for image transfer between screens both within a diagnostic unit and between different diagnostic units.

The transfer of film to digital image archives by scanning of film and other documentation of patient examinations involves a severely increased work effort and administration within the diagnostic unit, even if this is made selectively and may be limited to arising demands. Thus, diagnostic units, which during transition to digital technique, determine not to archive or store film, have to transfer all film by scanning. To transfer a conventional film archive in its entirety must be considered as a very comprehensive work effort and may hardly be motivated, since the comparison between old and new images usually needs to be performed when it has been found necessary. The film archives usually comprise a large number of films depending on the request prescribed by law to archive 10 years of film production on a running basis. In a regional/university hospital the film archive comprises about 10 million films, in a general hospital about 4 to 5 million films and in a smaller hospital about 1.5 to 1.8 million films spread over a ten years period.

The reading time for each scanned film is about a minute. In practice the complete process, including taking out or transfer patent documentation takes 15 to 20 minutes for each patient and examination. To transfer the film archive in this manner to a digital archive requires an almost unreasonable and costly work effort corresponding to about 1500 man years for each regional hospital, about 600 man years for each central hospital and about 200 man years for each smaller hospital.

When the film is moved from the film archive or the light cabinet for being put into the scanner there is a certain risk for the film being by mistake turned in the wrong way. The risk is particularly great when the work is carried out by less qualified personnel.

Conventional scanning is only in exceptional cases carried out by radiologists, since the diagnostic moment of the process constitutes a lesser part of the entire work. Therefore, the major part of the work is transferred to less qualified manpower with some guidance of the radiologist. In this way an important part of the diagnostic valuation is jeorpardized in respect of accurate selection of old films within pathologically interesting areas from previous examinations.

Conventional scanners are intended to transfer a complete film of occurring format and without any possibility for diagnostic discrimination, e.g. partial enlargement of pathologically interesting areas, partly because the scanner normally lacks the technical function for enlargement, partly because the scanner is closed and thus hides the film from examination and choice of enlarged area.

Thus, when a conventionally scanned film is partially enlarged on a screen, the image quality will be deteriorated proportionally to the degree of enlargement, as the number of picture elements, or pixels, will remain constant for the different parts of the image. A pathalogically interesting area is considered to have n pixels in x and y dimensions without any magnification. At 2 times magnification the number of pixels will be halved to the number of n/2, i.e. the resolution of the image will be deteriorated with 50%. It is also possible to describe the technique in such a way that the

pixels are magnified proportionally to the object magnification.

Using such a conventional, more or less systematical scanning there is thus a risk that important pathological areas are lost, which may lead to difficulties when making diagnosis and even to erroneous diagnosis.

An alternative in this respect is to use scanners having very high resolution. They are, however, very expensive and further they involve a heavily increased need of storing capacity in the image archive and a heavily increased time consumption for the image transfer. A doubling of the resolution of the scanner will e.g. give a quadrupling of the storage need for the image in the archive and of an image transfer time. A conventional scanning will not, for practical reasons as regards time and resources, admit that appropriate films and parts thereof are selected for internal consultation during a round in order later to be used for determining the clinic diagnosis.

Further, a conventional scanning does not allow that photographic images of diagnostic interest, e.g. images of patients having so-called scolios backs, are transferred as a supplementary aid to the rest of the image basis of the patient.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a system for image transfer of medical images, particularly X-ray images, or parts thereof, for diagnosis to digital, electronic form and for archiving of these digital, electronic images, which system lacks one or several of the problems, which may arise using a known scanning system.

This and other objects are according to one aspect of the invention attained by a system for transfer of medical images as defined in claim 1.

According to a second aspect of the present invention there is provided a system for image archiving and communication, particularly a system of the PACS (Picture Archiving and Communications System) type as defined in claim 13.

Is is a further object of the invention to provide a method for said type of image transfer.

This object is according to a third aspect of the present invention attained by a method for transfer of medical images as definied in claim 14.

An advantage of the present invention is that it provides for flexible, fast, accurate and simple image transfer, which makes it ideal with teleradiologi.

A major advantage of the invention, compared with conventional scanners, is that the image for digitalization may be looked at and judged and, if required, adapted before the digitalization is performed and thus not afterwards.

A further advantage of the invention is that a selective partial enlargement of pathologically interesting areas is made possible, whereby parts only of some images have to be transferred, which involves a considerably saving as regards partly transfer time, partly storing space in the digital, electronic archive in comparison with use of a conventional scanner having an extremely high image resolution.

Yet a further advantage of the present invention is that image transfer may be performed in connection with an X-ray round or prediagnostics, wherein pathologically interesting objects may optionally be magnified and transferred to a digital, electronic archive.

A particular advantage of the invention is that it hereby lifts the transfer process up to an appropriate level as the method motivates persons having diagnostic competence to optimize the basis for diagnostic consultation and final opinion. The risk for turning the film upside-down in a scanner is reduced.

Further advantages of the invention will be apparent from the following description.

SHORT DESCRIPTION OF THE DRAWINGS

The invention will now be described closer below with reference to Fig. 1, which is given by way of illustration only and shall therefore in no way limit the invention.

Fig. 1 is a perspective view of an embodiment of a system for transfer of medical images according to the present invention.

PREFERRED EMBODIMENTS

In the following description, for describing and not limiting purposes, specific details are set forth in order to provide a thorough understanding of the present invention. However, it is obvious to the man skilled in the art that the invention may be practised in other embodiments, which deviate from these specific details. In other instances, detailed descriptions of well-known techniques are omitted in order not to ob-

scure the description of the present invention with unnecessary details.

The terms "images" and "film", respectively, in this description principally refer to developed X-ray film but any other kind of image or film for medical application shall be included in these terms.

With reference to Fig. 1, a system 1 for transfer of medicial images, particularly X-ray images, according to the present invention comprises a highly resolving digital camera 11 of the CCD type with a lens 13 mounted at a positioning system 15. The camera can be of conventional kind, which is available on the commercial market and may typically comprise about 1000-2000 x 1000-2000 picture elements or pixels or may be a professional camera with a considerably higher resolution than e.g. a conventional scanner in dependence on the demands and the desires of the radiologist. The lens is preferably comprised of an objective with a magnification function, i.e. a zoom objective, and a positioning system 15 is preferably comprised of a vertical pole 15a, a coordinate slider 15b and a list 15c. The digital camera is arranged such that it may at least be movable in a plane parallel to the plane, in which the medical images 17 to be transferred are arranged.

Preferably, the medical images 17 to be transferred are arranged on a vertical light surface 19 in e.g. a light cabinet 21 as illustrated in Fig. 1, but they may alternatively be arranged directly at a wall or other substantially plane surface (not shown). The camera, which in Fig. 1 is movable in a vertical direction through movement along the vertical pole 15a and laterally through movement of the coordinate slider 15b along the list 15c, may, however, also be movable in a third di-

rection, at right angles to the above-mentioned directions.

The digital camera 11 is connected to a computer 23, integrated in the system 1, with a screen 25, via an input/output 27 arranged at the camera, which computer is in turn connected to a digital electronic image archive (not shown in Fig. 1) through a cable 29. Alternatively, the digital camera 11 may be directly connected to a computer in a digital information system of a diagnostic unit on the assumption that the necessary technical adaption is performed.

The system 1 is arranged in such a way that the transfer may comprise the following points:

- Positioning of the digital camera for scanning of medical images.
- Examination of the medical images either in the finder of the camera (if it is provided with a finder) or on the screen 25. This examination may be selectively performed i.a. in order to find pathologically interesting parts.
- Magnification of selected images or parts thereof of the group of examined images, particularly the ones having pathologically interesting parts, to an optional degree limited by the magnification capacity of the camera only, i.e. the longest focal distance and the closest imaging distance of the zoom objective. By choosing an appropriate equipment the actual resolution, which may be achieved and by which images may be transferred, is equal to the resolution of the original images

(which is in the same order of magnitude as the grain size of the chemically developed film).

- Exposure of images, or parts thereof. In this respect occurring films may be imaged with any resolution within the range of the performance of the system and the resolution of the original images.

- Transfer of any images to the digital electronic image archive. This is preferably comprised of a system of the PACS type, which is an integrated network-based system for medical information. The transfer may comprise communication with a patient information system RIS (Radiological Information System) included in the PACS for input of patient data and other data and conversion of the images to a suitable format for the PACS.

One of the advantages of using a computer for image transfer is, as mentioned, that the operator, during positioning of the camera and choice of partial enlargement, may, except of using the finder of the camera, examine images on the screen of the computer before the digitalization of the image. The operator is preferably a clinically qualified person with knowledge about diagnostic discrimination. The invention motivates persons with diagnostic knowledge to perform the transfer process simultaneously with the optimization of the basis for diagnostic consultation and final statement.

Another advantage is that the screen of the computer or, when necessary, a secondary device and, for the purpose, a more highly resolving screen may be used for the image exposure and thereby the risk for motion

blurr will be reduced, which may arise at heavy image magnification and incautious contact with the camera during exposure.

The system may be arranged for manual and preferably motorized (not shown) movement of the digital camera in the horizontal and vertical directions. The camera may in this respect be arranged for scanning of a film examination surface, particularly in a light cabinet.

The video output of the camera may be used for image presentation during the round routine consultation for diagnostics and in such a case either via the computer, which is connected to the digital camera, or via external screens included in the digital image system of the unit.

To connect selected film examination with magnification of pathologically interesting objects to PACS and other types of digital image archives is time saving and may be performed by clinically qualified personnel when practising out internal prediagnostics and consultation during the round routine. When necessary, the complete work, or parts thereof, may be prepared before the round.

The system for image transfer of film to the digitial system of the diagnostic unit may further present occurring films with elucidating magnification at team work for diagnostic consultations.

By performing image presentation and transfer of film already arranged in a light cabinet the risk for erroneously turned films is also reduced.

There is undebatably a great need for image transfer of analog film to digital image archives and with a possi-

bility to enlarge pathologically interesting objects and simultaneously preparing an optimal judgement basis for determining of a clinical diagnosis.

A drawback of the image transfer is the risk for introduction of undesired and unintended motion unsharpness, which may make a planned and expected result of an approaching diagnosis for the patient difficult and even impossible.

The risk for motion unsharpness to arise using the present invention is considerably higher than using a conventional scanner, which consists of a closed system where neither the camera nor the film may be affected by external contact. The image deterioration due to motion unsharpness will increase with increased magnification of the object. There are mainly two types of motion unsharpness, namely a moderate decaying motion (e.g. after a hit) and a constant motion (e.g. a permanent vibration caused by an electrical apparatus).

Contact with film and/or camera in connection with camera exposure and image transfer will to a varying degree generate a motion unsharpness for the imaged object, which will increase proportionally to the used magnification level.

There is a risk that the user will not observe the motion unsharpness arising after activation of the camera exposure but before the exposure and storage of the image/film for image transfer. Rejection of films after scanning involves that important diagnostic patient information is irrevocably lost and in order to prevent this, each scanned film should need to be examined separately before rejection.

The motion unsharpness may, according to the present invention, be carried out through active, dynamic image analysis of the camera image in one or two steps. By e.g. measuring the position, i.e. the coordinates for a selected detail on the film at two different occasions, a motion may be detected. Thus, the motion unsharpness is determined depending on the fact that temporal image position variations for a predetermined detail of a medical film are detected. Alternatively, the motion unsharpness is determined depending on the fact that the temporal intensity variations in a simple image element are detected.

The allowed value of the motion may either be chosen according to a predetermined value or be given by the user from case to case.

Step 1 implies that the exposure of the image is prevented (e.g. the exposure mechanism is locked) when the allowed value of the motion unsharpness is exceeded before exposure. Step 2 implies that the image transfer is stopped (i.e. an exposed image is directly rejected), when the allowed value of the motion unsharpness is exceeded for an exposed image.

The prevented or stopped image transfer may either be absolute or be a temporary obstacle in the form of an option that the image does not comply with the demands put on the resolution but may anyhow be exposed and/or transferred to the digital archive if the user accepts this deviation.

The motion unsharpness caused by permanent vibration with constant amplitude may be compensated by making an average image of more picture fields with digital image analysis.

To sum up, supervision and measure in respect of motion unsharpness are based on comparison of the coordinates of the image matrix at two different occasions, e.g. before and after the exposure of the image.

In order to optimize the contrast of the image the strength of the light ought to be adapted to the individual density range of the images, which involves an unnecessary operation moment, since the image examination per se does not necessarily demand this light regulation. Depending on the use frequency this may be tiring and disturb the diagnostic work.

If this light regulation shall be made using a conventional scanner, it may at first be performed after judgement of the already digitized film, whereby the complete process may be repeated again when necessary.

Light regulation in order to optimize the contrast of the image has a very great diagnostic value. The invention makes possible choice of a so-called dynamic contrast optimization, i.e. the contrast ranges of the image is utilized over the entire grey scale or a manually chosen contrast level.

Possibly, the camera may also be provided with a diaphragm, which automatically chooses the aperture depending on the dynamic range of the film.

To sum up, by means of the system according to the invention, any images, particularly magnifications with improved resolution of pathologically interesting parts, and flexible image transfers to the digital system of the diagnostic unit for image processing and archiving may be performed using a film of already made patient examinations. By combining film examination with magnification/digitalization/reading/storing in

connection with the round routine pathologically interesting objects may optionally be magnified for simultaneous consultation and transfer to a digital image archive.

Partial magnification of pathologically interesting objects is an enormous advantage in comparison with conventional scanning with limited resolution and a considerable saving of image storage and transfer time in comparison with using a conventional scanner with extremely high image resolution. When transferring the entire image, an unnecessary large image surface will then be stored with unused image resolution and will have a correspondingly larger storage space in the digital archives at its disposal in comparison with the invention.

The transfer system according to the present invention is flexible, fast, accurate and simple to use, which results in an ideal system for teleradiology over network.

The present invention as described above solves the problems, which are associated with known technique. It is, of course, not limited to the embodiments described above and shown in the drawings but can be modified within the scope of the appended patent claims.